Circadian Rhythm in Demented and Non-demented Nursing Home Residents Measured by the IST Vivago® WristCare Activity Signal

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Summary

The quality of sleep is associated with the well-being of the elderly. Dementia affects sleep and sleeping problems are common in demented subjects. Efficient treatment requires tools for long-term monitoring of sleep quality. We compared the circadian rhythm measured by the IST Vivago® WristCare activity signal in demented and non-demented nursing home residents.

Introduction

Sleeping disorders and disturbed sleep/wake rhythm commonly occur in demented elderly subjects. These problems are significant factors in the decision to seek nursing home placement [1,2]. Monitoring sleep/wake patterns would improve the diagnosing of sleep problems and assessing the efficacy of treatments. Wrist actigraphy has been used for the monitoring of circadian rhythm at home. However, traditional wrist actigraphs are not suited for true long-term monitoring.

IST Vivago® WristCare (IST International Security Technology Oy, Helsinki, Finland) is an active social alarm system, which provides continuous telemetric monitoring of the activity of the user [3]. The activity signal provides similar performance in sleep/wake pattern detection as actigraphy [4].

Objectives

In this paper, we studied how the activity signal measured by IST Vivago® Wristcare differs in non-demented and demented subjects and developed parameters for quantifying the quality of sleep/wake rhythm and circadian patterns in long-term recordings.

Methods

26 subjects (2 men and 24 women, mean age 83 years) living in a nursing home volunteered for the study, which was approved by the local ethical committee. 14 subjects were non-demented (CDR≤0.5) and 12 subjects demented (CDR>0.5). The demographics of the groups were similar with the exception of cognitive performance.

The activity signal was recorded for 10 days. The duration of sleep, self-assessed quality of sleep, and daytime as well as evening alertness were self-assessed (non-demented subjects) or assessed by the nurse (demented subjects).

The activity signal was processed by the calculation of parameters daily. Day was defined from 9 a.m. to 9 p.m. and night from 12 p.m. to 6 a.m. Mean, median and standard deviation of activity for the whole 24 hours, for day and for night were computed. Rhythmicity was studied by night/day ratio. Poincare analysis was used as a method for quantifying the existence of circadian rhythm in activity.

Results

Measured activity signal and computed parameters differed significantly between non-demented and demented subjects (Mann-Whitney U-test, Table 1). Functional capacity assessed by Barthel scores correlated with the WristCare activity signal (Spearman rank order partial correlation controlled for MMSE, r=-0.46 between Barthel scores and night/day activity ratio). Subjective assessments of sleep quality and alertness did not differ between groups.

***Table 1**. Differences in selected activity parameters between non-demented and demented groups.*

	Non-demented n=14	Demented n=12	
	Mean (SD)	Mean (SD)	p-value
$Poincare_{24h}$ SD1/SD2	0.69 (0.10)	0.84 (0.09)	0.001
$Poincare_{24h-12h}$	0.69 (0.34)	0.27 (0.17)	0.001
Mean 24h	1.32 (0.30)	1.16 (0.32)	ns
SD 24h	1.20 (0.31)	0.81 (0.17)	0.002
Median 24h	1.01 (0.27)	1.07 (0.44)	ns
Mean night	0.46 (0.19)	0.78 (0.28)	0.001
SD night	0.58 (0.17)	0.62 (0.15)	ns
Median night	0.27 (0.15)	0.63 (0.32)	<0.001
Mean day	1.87 (0.51)	1.43 (0.37)	ns
SD day	1.13 (0.27)	0.76 (0.20)	0.001
$Night/Day_{median}$	0.19 (0.13)	0.50 (0.20)	<0.001

Discussion

The activity signal produced by IST Vivago® differed significantly in non-demented and demented elderly people. It shows deprived circadian rhythm in demented subjects. Self-assessments did not detect the differences as well as the device. The results also suggest a potential association between functional capacity and diurnal pattern.

The activity signal provides good opportunities for both elderly care and research to assess sleep/wake patterns and sleep problems. Activity monitoring integrated to a social alarm system enables long-term (up to several years) follow-up of the general well-being of elderly people as poor circadian rhythm may be associated with various health problems and conditions of elderly people. A great advantage of the IST Vivago® is the integrating of activity monitoring in the social alarm system device, hence providing motivation for wearing the device.

WristCare is simple to implement.
For further information, please contact:

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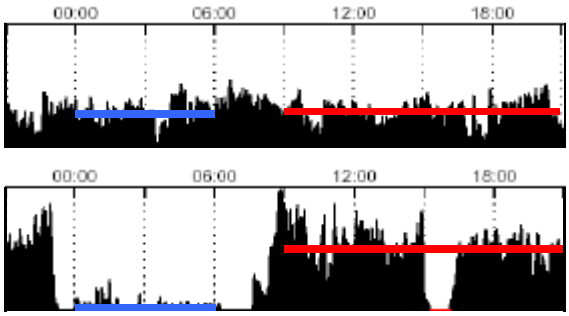

***Figure 1**. Examples of circadian rhythms produced by IST Vivago â activity signal. Poor diurnal rhythm of a demented subject in the upper graph, and good diurnal rhythm of a non-demented subject in the lower graph. Lines indicate median activities during the day and night.*

Conclusions

The IST Vivago® system provides a useful and promising instrument for monitoring sleep/wake patterns and the overall well-being of demented elderly persons both in institutions and at home.

References

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IST Vivago® : Case studies based on the activity signal

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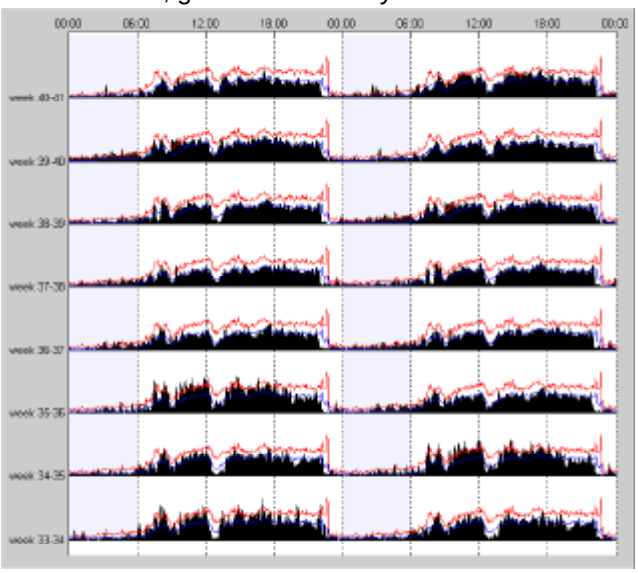
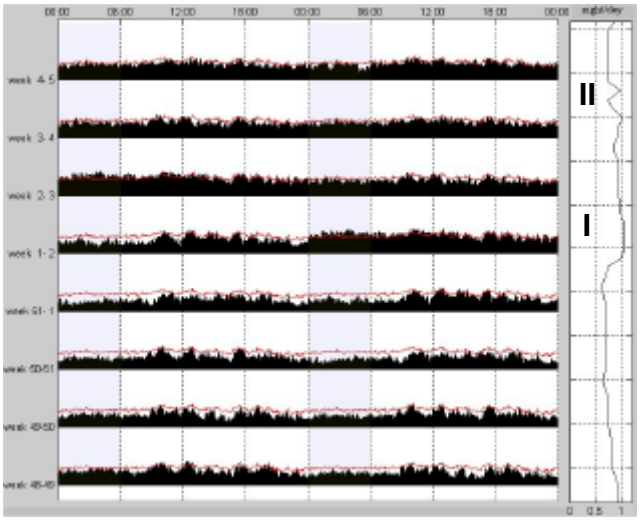
Case 1. Normal, good circadian rhythm.



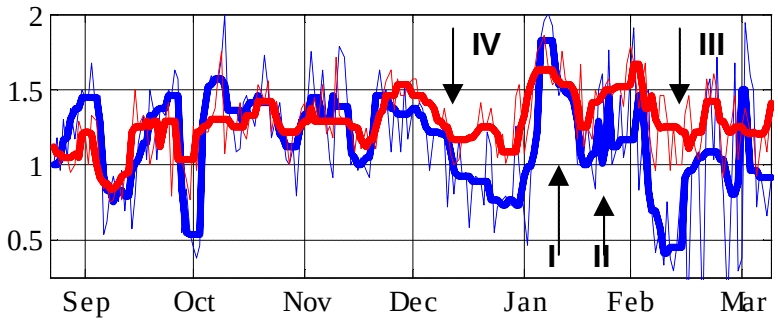
- 84- year old woman, mild memory disorders, MMSE score 21 and CDR class 0.5.
- Good functional capacity, Barthel score 90.
- No diseases, uses tranquilizers.
- Generally sleeps well and feels good.
- Clear circadian rhythm visible in the activity signal, low night time activity indicates good sleep, daily naps after lunch.

Case 2. Changes in health status are visible in the night time activity level and the ratio of night and day activities (curve on the right side of the graph).



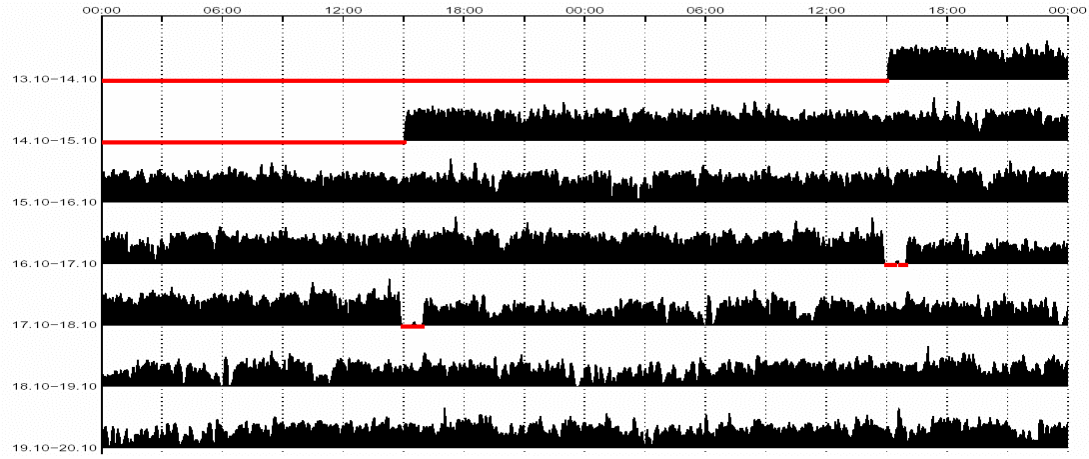
- 83- year old woman, basic disease Myastenia gravis.
- Functional capacity poor because of the basic disease, Barthel score 45.
- No dementia, mild memory disorders, MMSE score 23, CDR class 0.5.
- During winter several acute diseases:
  - Diagnosis of an urinary track infection on 15.1.2003, activity curve shows a change in the ratio of day and night time activities prior to the diagnosis (**I**).
  - Fever on 25. - 27.01.2003 -> diagnosis of bronchitis on 30.1.2003 (**II**), night time activity has risen prior to the diagnosis. After recovery, the activity curve shows better daily rhythm (night time activity drops clearly below day time activity) (**III**).
  - General condition becomes worse during spring 2003, hospitalized in early April 2003.

Day (red) and night time (blue) activities

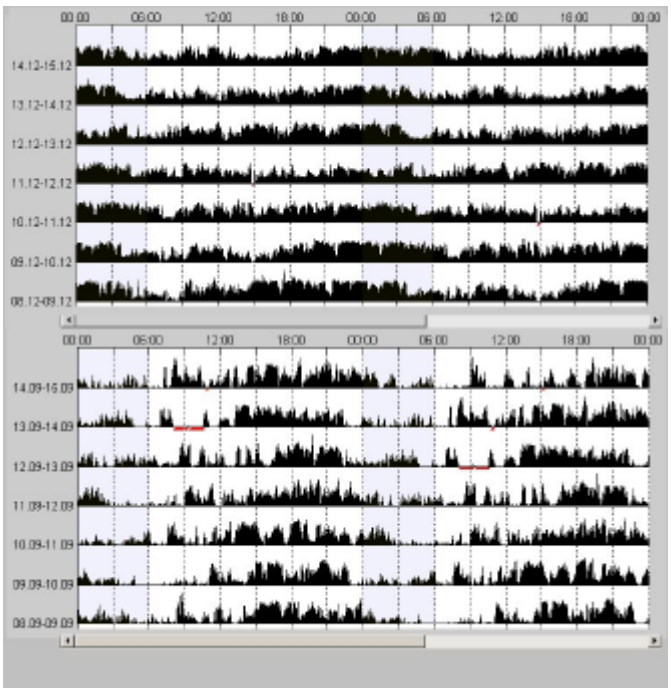


The restless room mate moves to another room in early December. This causes night time activity to drop, which improves the daily rhythm for some weeks in December (**IV**).

Case 3. The activity curve of a demented person: no circadian rhythm, activity continuously at a high level.

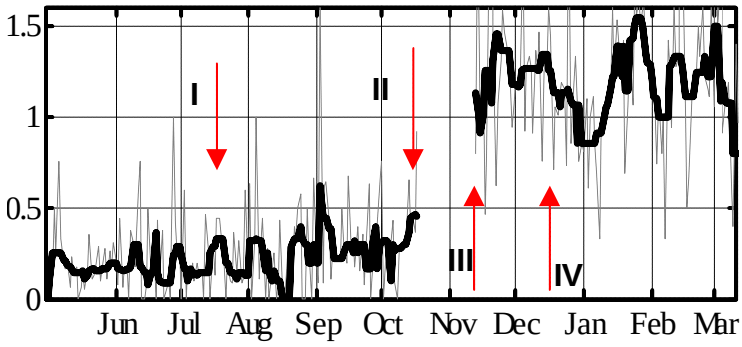


Case 4.



- 86- year old woman, coronary heart disease, cardiac insufficiency, and asthma. Poor functional capacity, Barthel score 20.
- Vascular dementia, MMSE score 20 and CDR class 1. Dementia advances during winter, MMSE score 15 in March 2003.
- Good circadian rhythm during the past year (**I**), hospitalized 15th of October because of the cardiac insufficiency and increasing pulmonary symptoms (**II**).
- Returns from the hospital on 11th of November (**III**), still in bad condition, sleeps poorly, tired during the day. The ratio of day and night activities shows bad or even reversed circadian rhythm (ratio close to 1).
- On 10th of December the cardiac insufficiency gets worse (**IV**), after this episode the night and day activity ratio temporarily improves (<1) .
- General condition weakens during winter, dementia advances, tired and fatigue, sleeps poorly. A few occasional better days.

Ratio of the night and day time activities



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Conclusions

Based on the results of the study, the activity signal may describe changes in health status in both the worse and better directions. The health records and the circadian rhythm derived from the signal often support each other very well. The results suggest that the signal may be used to monitor changes in health status and to follow up on the effects of treatment in elderly care institutions, and hence to support nursing practises.